Berg Steel Pipe Corp.
a Company of the Europipe Group

P.O. Box 59209
5315 West 19th Street
Port Industrial Park
Panama City, FL 32412-0209

Frederick R. Hafner
Chief Metallurgist/ QA Manager

Penny Hutt
Manager of Technical Services & Raw Materials

January 14, 2002

For API 5L Grade X70 & X80 Linepipe Capability Matrix

API 5L Grade X70 and Grade X80 linepipe are not commodity items; the customers define chemical and mechanical requirements for specific projects. The API 5L product specification provides only the minimum requirements for the grade.

Here are some specific examples of different products that are all encompassed by the same API 5L Grade X70 minimum product specification:

Alliance Pipeline

The Alliance Pipeline involved 36" diameter linepipe for a natural gas pipeline from Edmonton, Alberta to Chicago. Because the pipeline transports heavy hydrocarbons with the natural gas, high Charpy energy values were required to prevent long-running fractures.

Gulfstream Pipeline

The Gulfstream Pipeline involved 36" diameter linepipe for an underwater natural gas pipeline from Mobile Bay to Tampa Bay. Because this involved a high-pressure pipeline installed in up to 500 feet of water, heavy wall thickness was required and high Charpy energy values were required.

Because these pipelines are designed for specific applications, the required chemical and mechanical properties are different despite the same grade description. The plate width, plate thickness, tensile properties and impact properties are interrelated and the unique project requirements must be viewed against the capabilities of each plate mill. We will attempt to describe the interrelationships.

Charpy Test Absorbed Energy

To ensure pipeline safety, the pipeline design engineer must be concerned with ductile fracture arrest properties of the linepipe. As the pipe diameter, pipe thickness and percentage of heavy hydrocarbons in the gas increase, the Charpy energy required to arrest a ductile fracture increases.

From the plate manufacturing prospective, as the pipe diameter (plate width) increases and the plate thickness increases, it becomes more difficult to meet the Charpy energy requirement because the mill may lack separating force to make large reductions on each control rolling pass.

At some combination of pipe diameter and thickness, the Charpy energy required by the pipeline design will exceed the limitations of the plate mill.

Low sulfur levels also contribute to high Charpy energy. The Alliance Pipeline and Gulfstream Pipelines required very high Charpy energy that necessitated a sulfur content of 0.003% maximum.

Field Weldability

Forty to eighty foot sections of linepipe are welded together in the field. The pipe must be suitable for field welding without cracking. This necessitates use of a high-strength, low-alloy steel that is control rolled with microalloy additions of niobium, vanadium and/ or titanium.

Elements that are particularly detrimental to weldability include carbon and manganese. These elements are however, important to achieving the strength requirements of the steel.

Elements such as copper, nickel, chromium and molybdenum are also detrimental to weldability. These elements are residual elements that tend to increase with the amount of steel scrap added during steelmaking.

The field welding techniques and field welding environments differ between pipeline projects. Each project may have different limits on these elements to achieve field weldability.

The specific field weldability requirements sometimes exclude plate mills with limited separating force and/or lack of accelerated cooling capability. The lack of thermo-mechanical processing capabilities would necessitate excessive alloy additions to achieve the required strength.

Drop Weight Tear Test

Portions of some pipelines are sometimes installed above ground or in arctic regions, where the pipeline is exposed to cold temperatures. This necessitates impact test properties at low temperatures to prevent a brittle fracture. The drop-weight tear test is often used to determine the ductile to brittle transition temperature of the steel.

In order to achieve satisfactory drop weight tear test results at low temperatures, rolling mills must have carefully designed control rolling schedules with heavy reduction in the final rolling passes at low finish rolling temperatures. As the plate width and thickness increases, the rolling mill may lack the separating forces to achieve the required drop weight tear test properties. Plate mills that have larger separating force capabilities and the capability of accelerated cooling after the final rolling pass are better suited for low-temperature impact test requirements.

General Limitations of the Domestic Industry

Since the requirements for a particular Grade X70 or X80 project are specified by the customer and a number of different sets of plate requirements are encompassed by the same API grade, it is difficult to define specific sets of requirements that cannot be achieved by the domestic plate industry. The chemical properties, tensile properties, impact properties are all interrelated. In general, the following plate properties are difficult to achieve with domestic Grade X70 or X80 plates:

Plate Width:	Bethlehem Steel is the only domestic plate supplier that has produced Grade X70 plates wider than 120 inches for Berg. Bethlehem Steel's maximum plate width is 150 inches.
Plate Thickness:	Combinations of mill separating force, rolling schedules, and accelerating cooling are generally not available to achieve a thickness greater than 0.720 inches in Grade X70.

Charpy Test Absorbed Energy:	Combinations of sulfur level and control rolling schedules are generally unavailable to achieve Charpy energy levels greater than 80 ft-lbs
Drop Weight Tear Test Temperature:	Combinations of mill separating force, rolling schedules, and accelerating cooling are generally not available to achieve drop weight tear test transition temperatures lower than -20° F.